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July 15, 2016

EX PARTE NOTICE VIA ECFS

Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: ET Docket No. 15-26, *Amendments of Parts 1, 2, 15, 90, and 95 of the Commission's Rules to Permit Radar Services in the 76-81 GHz Band*
ET Docket No. 11-90, *Amendment of Sections 15.35 and 15.253 of the Commission's Rules Regarding Operation of Radar Systems in the 76-77 GHz Band*
ET Docket No. 10-28, *Amendment of Section 15.253 of the Commission's Rules to Permit Fixed Use of Radar in the 76-77 GHz Band*
WT Docket No. 11-202, *Amendment of the Commission's Rules to Permit Radiolocation Operations in the 78-81 GHz Band*

Dear Ms. Dortch:

On July 13, 2016, Daniel Selke of Mercedes-Benz USA, LLC ("MBUSA"),[1] Thomas Weiss of Daimler Aktiengesellschaft, and Ari Fitzgerald, Counsel to MBUSA, met with Patrick Forster, Howard Griboff, Jamison Prime, and Matthew Hussey of the Commission's Office of Engineering and Technology.

During the meeting, the parties reviewed the attached presentation regarding the FCC's proposal to permit vehicular radar operations in the 76-81 GHz band.[2]

Pursuant to Section 1.1206(b)(1) of the Commission's rules, I am submitting a copy of this letter and the accompanying presentation into the proceeding record.

Sincerely,

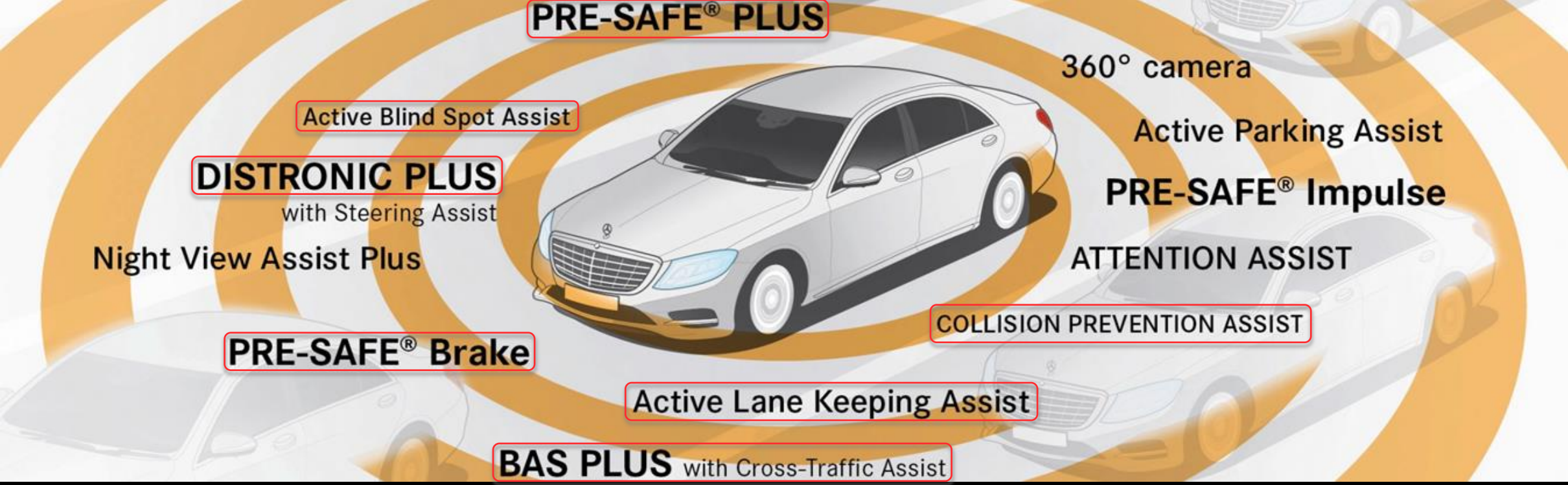
/s/ Ari Q. Fitzgerald

Ari Q. Fitzgerald
Counsel to Mercedes-Benz USA, LLC

[1] Mercedes-Benz USA, LLC is a subsidiary and the registered agent of Daimler Aktiengesellschaft.

[2] Amendment of Parts 1, 2, 15, 90 and 95 of the Commission's Rules to Permit Radar Service in the 76-81 GHz Band, *Notice of Proposed Rulemaking and Reconsideration Order*, 30 FCC Rcd 1625 (2015) ("*NPRM*").

cc: Patrick Forster
Howard Griboff
Jamison Prime
Matthew Hussey



Mercedes-Benz

Radar Applications in the 76 - 81 GHz Band

Ex Parte Presentation ET Docket No. 15-26

Thomas Weiß, RD/FZS
July 13, 2016

Mercedes-Benz
The best or nothing.

Ex Parte Presentation of Mercedes-Benz

Overview

Sunset Regulation for 24 GHz Ultra-wideband Vehicular Radar Applications

- Mercedes-Benz comments in the FCC's 76 – 81 GHz proceeding

Status of Vehicular Radar in the 76 – 81 GHz Band

- Background on ITU Agenda Item 1.18
- Regulatory situation in Europe and the USA
- Evolution of automated driving
- Efficient spectrum use of vehicular radar systems
- Vehicle to Vehicle Interference-mitigation strategies
- Fixed Radar applications
- Fixed to vehicle interference
- Propagation of interference along the victim radar signal processing chain
- Summary
- Comments on the FCC's Notice of Proposed Rulemaking

24 GHz Radar Applications

Comments on the FCC's Notice of Proposed Rulemaking

24 GHz wideband and ultra-wideband devices

- **The Commission should leave undisturbed the ability to obtain new equipment certifications for wideband (§15.252) and ultra-wideband (§15.515) radars.**

On Transition Periods

- The proposal to prohibit new wideband and ultra-wideband 24 GHz vehicular radar equipment within 30 days will not leave stakeholders with sufficient time to adapt.
- Product cycles in the automotive industry require longer lead times than in other industries regulated by the FCC.
- Automobile manufacturers have made plans and contracts beyond 2022.
- Automobile manufacturers and their suppliers need reasonable transition periods.
- The proposed period of 30 days is a far shorter phase out period than in other parts of the world.

- **The FCC should not implement any phase out period shorter or narrower than the current regulation within the CEPT- and European countries.**

24 GHz narrowband equipment

- Devices under Section 15.245 and 15.249 belong to the most common radar devices and are being used by almost all automobile manufacturers.
- These sensors are also used outside of the automotive industry.
- We assume that the Commission does not propose to phase out the ability to certify new narrowband 24 GHz vehicular radar equipment under Section 15.245 and 15.249.
- The certification of new 24 GHz narrowband vehicular radar equipment has not been phased out in Europe nor anywhere else in the world.

- **The Commission should clarify its intent not to prohibit new narrowband 24 GHz vehicular radar equipment under §15.245 and §15.249**.

76 – 81 GHz Frequency Band

Regulatory Situation on ITU-Level

The World Radio Conference 2015 (WRC15) approved Agenda Item 1.18

*"to consider a **primary allocation** to the radiolocation service for automotive applications in the 77.5-78.0 GHz frequency band in accordance with Resolution **654 (WRC-12)**;"*

Key Content of Resolution 654 of WRC12

- Allocation of the Band 77.5 – 78 GHz to the radiolocation service ***to support automotive short-range high-resolution radar*** operations.
- These systems are **significantly contributing to road safety**.
- Safety related applications that benefit from **global harmonization.**
- A **global spectrum allocation** would be beneficial in terms of **efficient use of spectrum and economics-of-scale**.
- 76 – 77.5 and 78 – 81 GHz are already allocated to the radiolocation Service on a **primary basis** in all three ITU regions.

As a prerequisite for a primary allocation in the 76 – 81 GHz band:

- Automotive short-range high-resolution radars have been **precisely described** (see ITU R M.2057); and
- ITU has **studied** automotive SRR (See ITU R M.2322).

➢ **To our knowledge none of the other radar applications being considered in ET Docket No. 15-26 have been described nor studied so far.**

ITU R M.2322 comprises sharing studies of vehicular radars with…

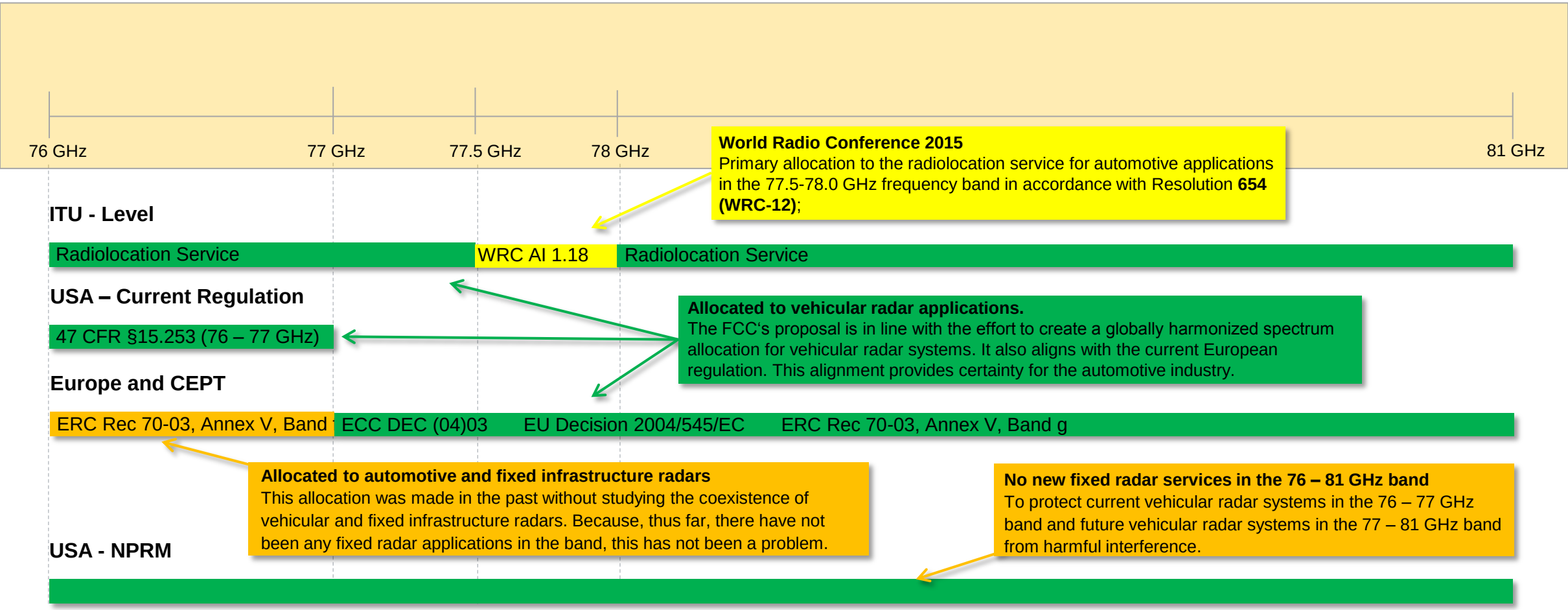
- Amateur and amateur-satellite services (Primary)
- Space research (space-to-Earth) service (Secondary)
- Radio astronomy service (Secondary)

and compatibility studies in

- The adjacent frequency bands 76 – 77.5 and 78 – 81 GHz

76 – 81 GHz Frequency Band

Regulatory Situation on ITU-Level, in the USA and in Europe



Evolution of automated driving

Assistance Systems
Current Technology

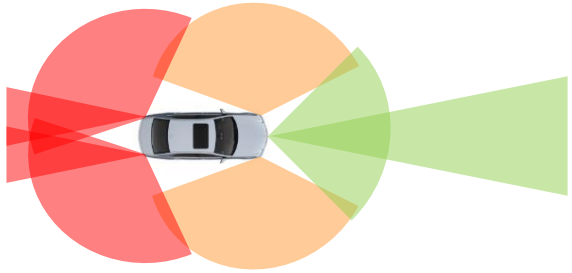
24 GHz and 76 GHz Radar
(24–29 GHz and 76–77 GHz)

State of the art radar based driver assistance systems that increase comfort and safety far above the average.

The systems support and assist the driver. Any drive operation has to be initiated by the driver.

The vehicle is at all times under the full control of the driver. The driver is fully responsible for all operations of the vehicle.

Partial and conditional automation
Next Steps



76 GHz Radar
(76–77 GHz)

Significant expansion of functions that support and relieve the driver in particular situations.

The vehicle will assist the driver during defined driving operations, but the driver is required to remain attentive and to supervise the driver assistance functions.

The vehicle is at all times under the supervision of the driver. The driver is fully responsible for the correct application of autonomous driving functions and for the operation of the vehicle.

Fully Autonomous Driving Vehicles
Future Applications

79 GHz Radar
(76–81 GHz)

The fully autonomous driving vehicle will completely relieve the driver in all situations.

The vehicle will navigate fully autonomously and take control of any driving operation independently of the driver. The driver may turn his or her attention to other activities.

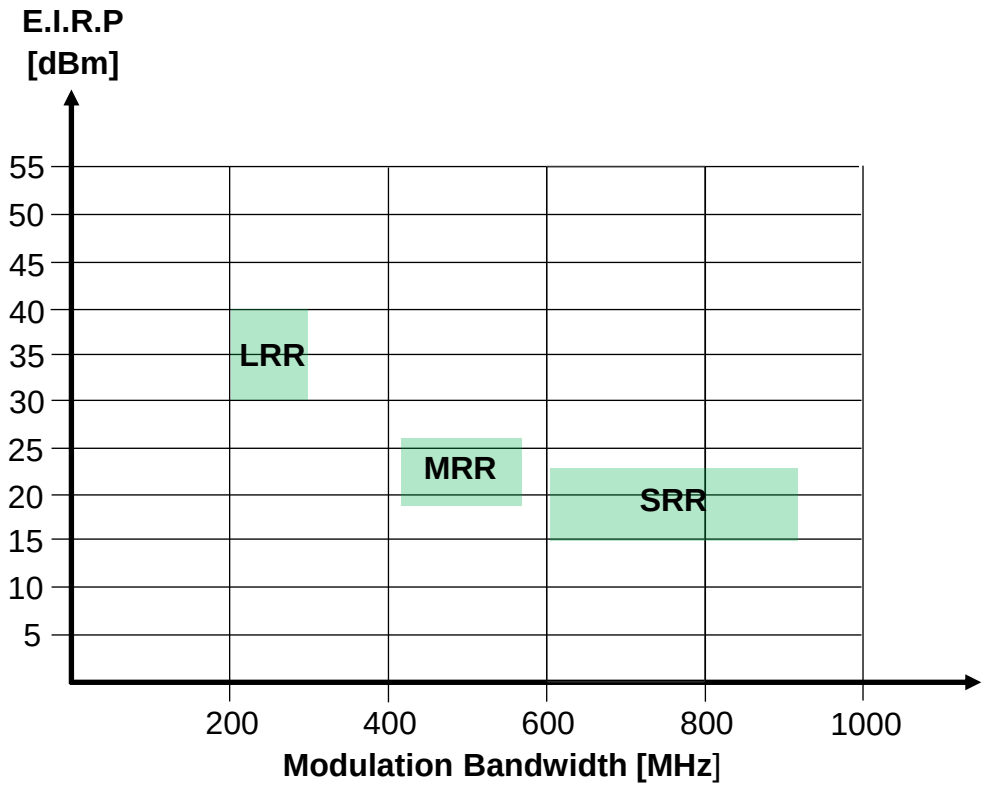
The vehicle takes full control of all driving operations without supervision by the driver. Redundant systems guarantee the faultless operation of these vehicles.

If the radar‘s operation was entirely lost due to harmful interference comfort and safety would go back to a normal average level.

Autonomous driving will not be possible without reliable high resolution radars.

76 – 77 GHz Frequency Band

Efficient spectrum use of vehicular radar systems

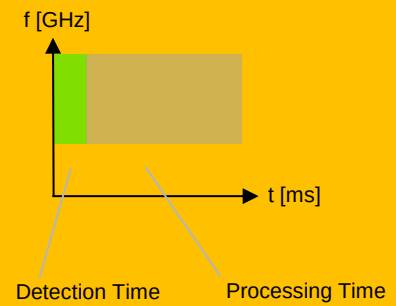


Vehicular Radar Systems are designed to minimize spectrum-use by

- Time (duty cycle)
- Space (beam patter)
- Energy (Tx-Power)
- Occupied bandwidth

Vehicular Radar Systems are designed for efficient spectrum use

Vehicular Duty Cycles



Duty Cycles usually have a **Total Duration** of ~ 50 ms.

They can be broken down into **Detection Time** (~10 ms) and **Processing Time** (~ 40 ms).
Occupied Bandwidth ~ 200 MHz

Typical Long Range Radars (LRR)

- Need to look far ahead
- Need a strong signal
- Focus energy output
- Primarily focus on detecting objects early rather than precisely

Therefore:

- Have a narrow beam pattern
- Typical 30 dBm (legacy system up to 40 dBm) Tx-power
- 200 – 300 MHz occupied bandwidth

Typical Short Range Radars (SRR)

- Need to observe the nearfield (only)
- Want to see as much as possible
- Need to measure distances precisely
- Need a good spatial resolution

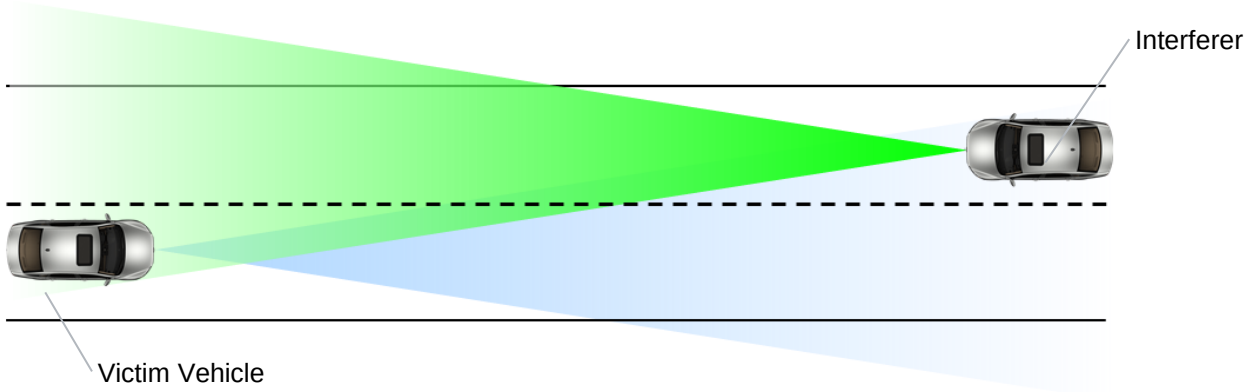
Therefore:

- Have a wide beam pattern
- Use 15 to ~20 dBm Tx-power
- Occupy up to 1 GHz bandwidth

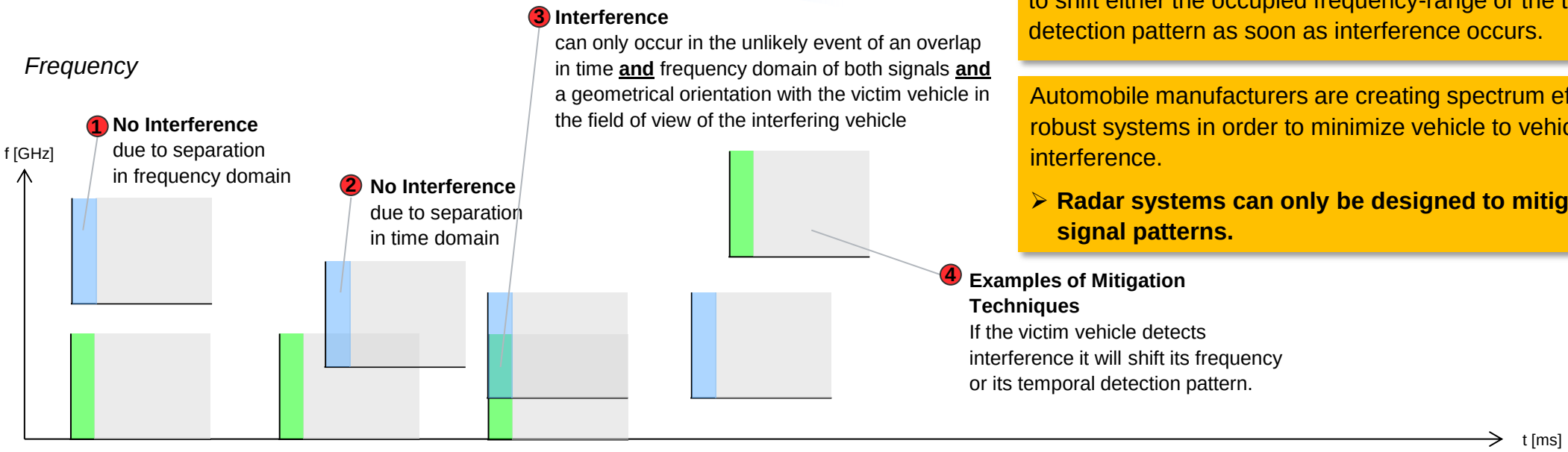
76 – 77 GHz Frequency Band

Vehicle to Vehicle Interference-mitigation strategies

Geometrical Orientation



Frequency



1 No Interference due to separation in frequency domain

2 No Interference due to separation in time domain

3 Interference can only occur in the unlikely event of an overlap in time **and** frequency domain of both signals **and** a geometrical orientation with the victim vehicle in the field of view of the interfering vehicle

4 Examples of Mitigation Techniques
If the victim vehicle detects interference it will shift its frequency or its temporal detection pattern.

Interference between two vehicular radars
Can only occur in the unlikely event of an overlap in time **and** frequency domain of both signals during their detection periods **and** a geometrical orientation with the victim vehicle in the field of view of the interfering vehicle.

To mitigate Interference
Many measures are in place at all stages of the signal processing chain. Two simple examples of effective mitigation measures are to shift either the occupied frequency-range or the temporal detection pattern as soon as interference occurs.

Automobile manufacturers are creating spectrum efficient and robust systems in order to minimize vehicle to vehicle interference.

- **Radar systems can only be designed to mitigate known signal patterns.**

76 – 77 GHz Frequency Band

Fixed radar applications

Known Fixed Radar Applications

- Foreign Object Detectors
- Tank Level Probing
- Perimeter Observation
- Observation of railroad intersections
- Traffic and Transport Infrastructure Radars

➢ There may be more new applications in the future

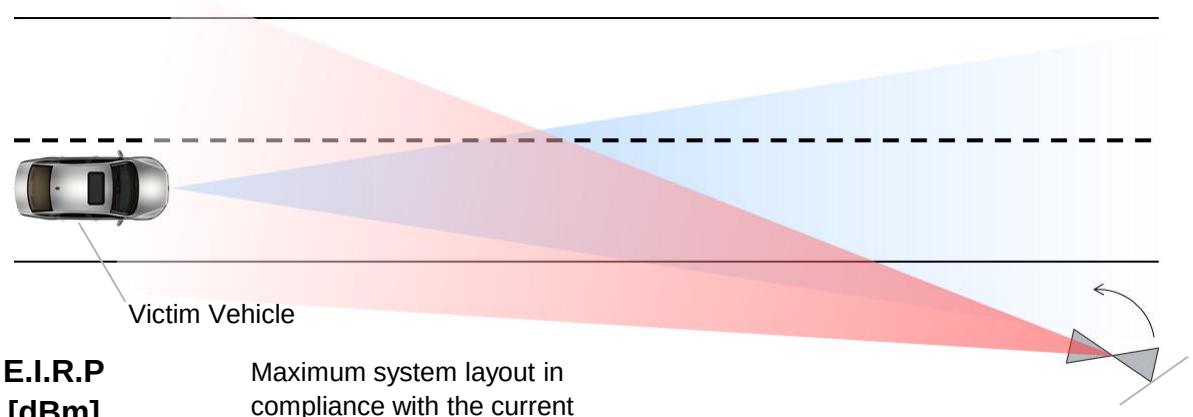
To our knowledge these applications …

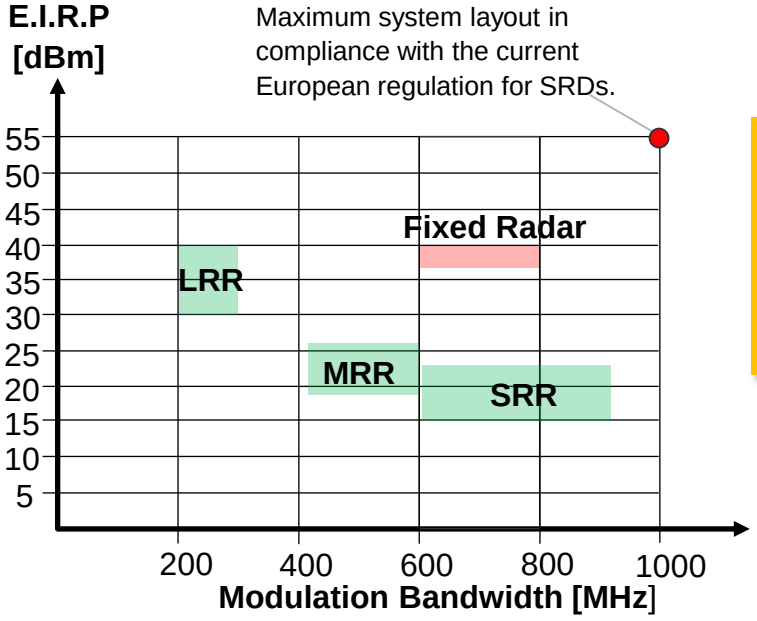
- Serve multiple different functions
- May have a wide range of signal characteristics
- Are hard to classify
- Have not been clearly described
- Have not been thoroughly studied for compatibility.

76 – 77 GHz Frequency Band

Fixed Radar by Navtec Radar ltd.

Geometrical Orientation





The Radar System by NAVTECH

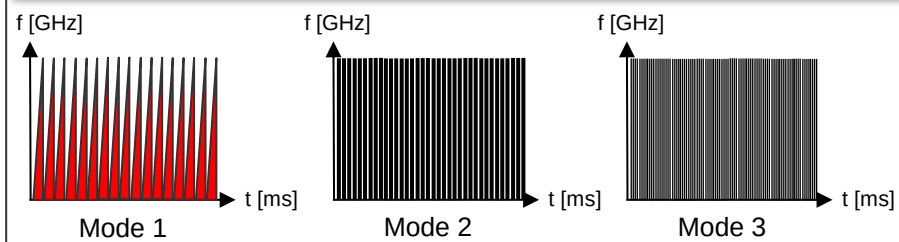
- Has a detection range of 500 m
- Covers 360° around any site with every rotation
- Uses up to 40 dBm peak power and up to 800 MHz occupied bandwidth

Modes of operation of the Fixed Radar by NAVTEC Radar ltd.
Specifications based on ETSI TR 103 148 and information provided by NAVTECH Radar ltd. during the European Coexistence study.

The fixed Radar installation has 3 modes of operation.

Mode	Sweep Time [ms]	Rotation [Hz]	Beam-width [°]	Dwell Time [ms]
1	2.000	1	2	5.56
2	1.250	2	2	2.78
3	0.625	4	2	1.39

Signal Pattern
The fixed radar is continuously transmitting and receiving.
For a static observer the signal seams to be intermittent due to the rotation of the system.

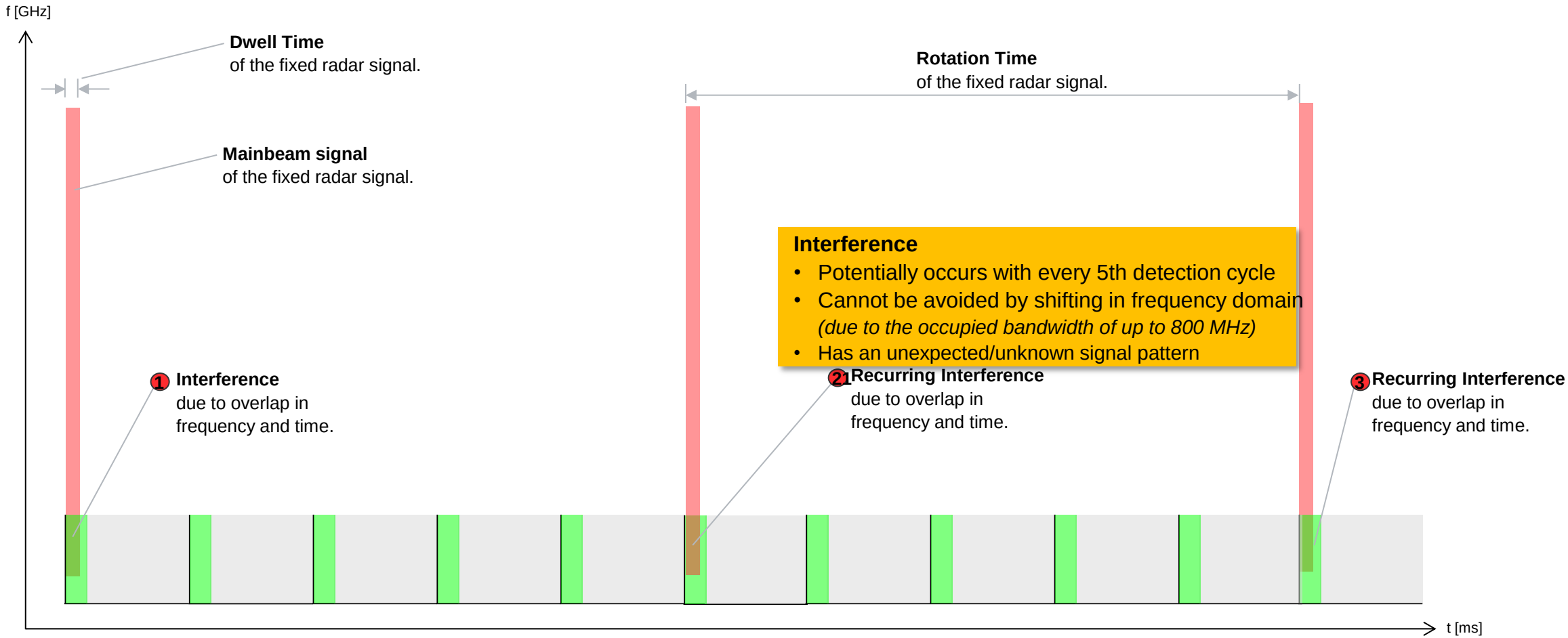


Further Specifications

Occupied Bandwidth	< 800 MHz
Tx Power	37 - 40 dBm E.I.R.P. (peak)
Mounting height	> 3,5 m

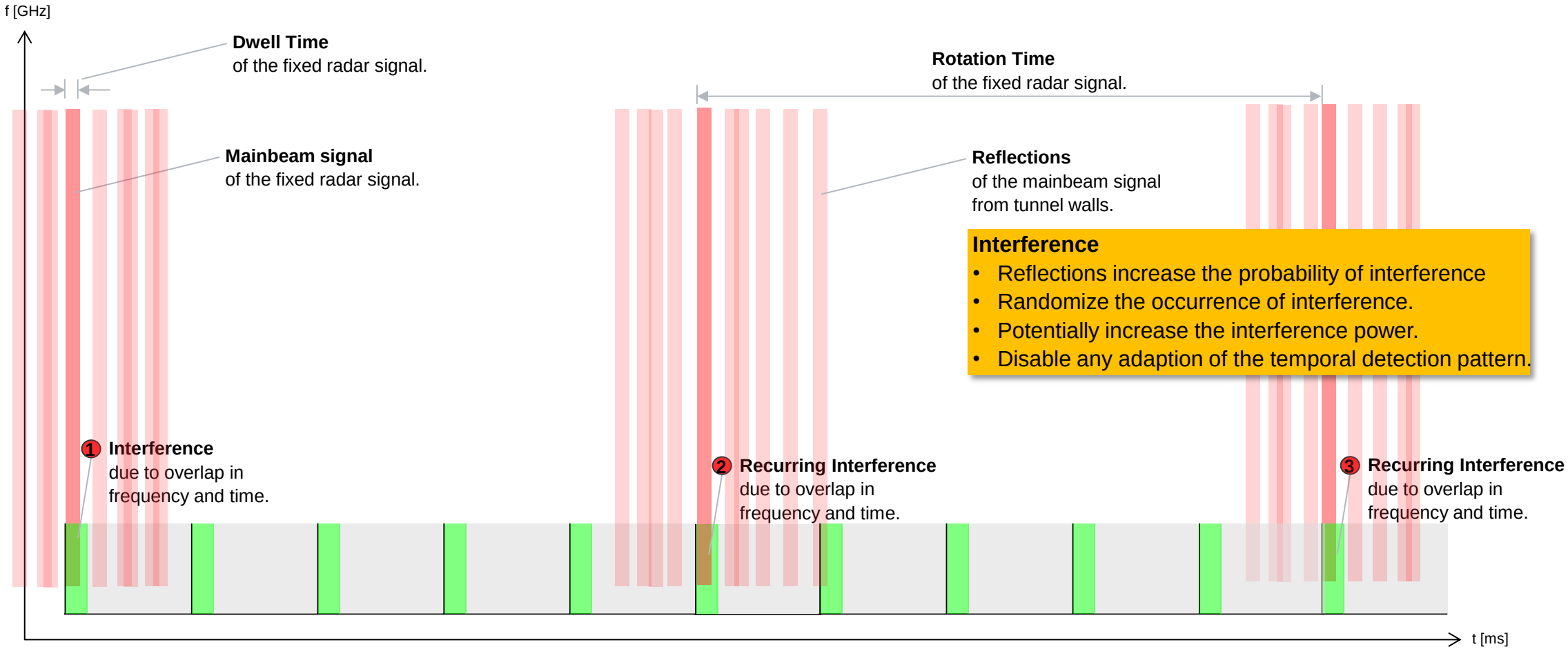
76 – 77 GHz Frequency Band

Fixed to Vehicle Interference - rotating fixed radar site by NAVTEC Radar, assuming free space propagation environment



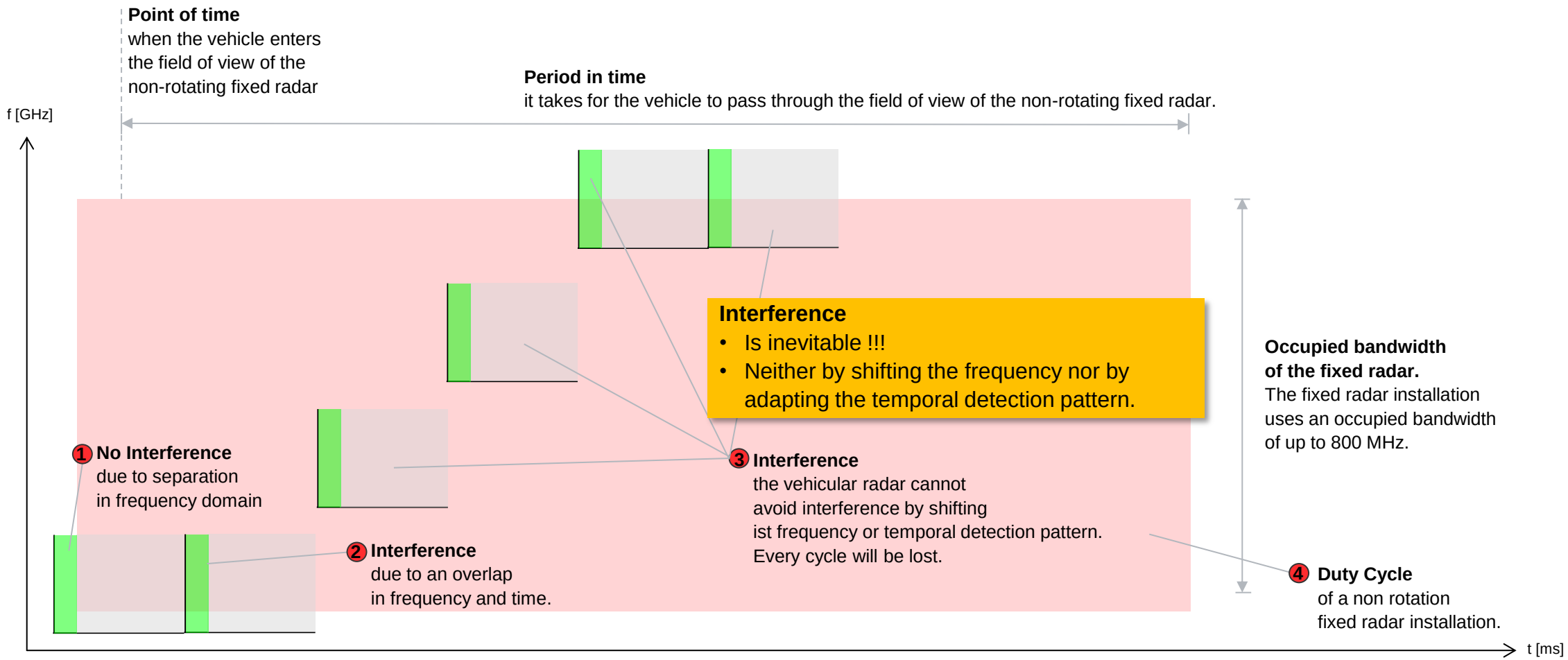
76 – 77 GHz Frequency Band

Fixed to Vehicle Interference - rotating fixed radar site by NAVTEC Radar, assuming a tunnel environment



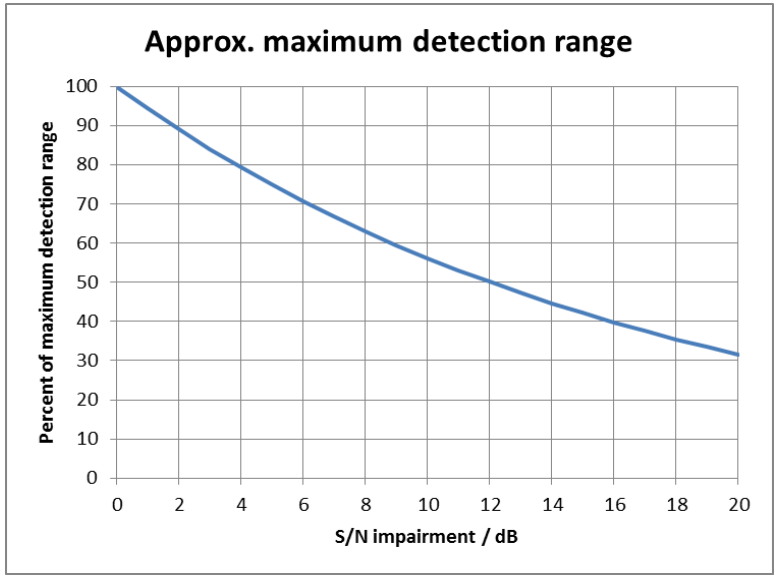
76 – 77 GHz Frequency Band

Potential Fixed to Vehicle Interference – assuming a non-rotating fixed radar site



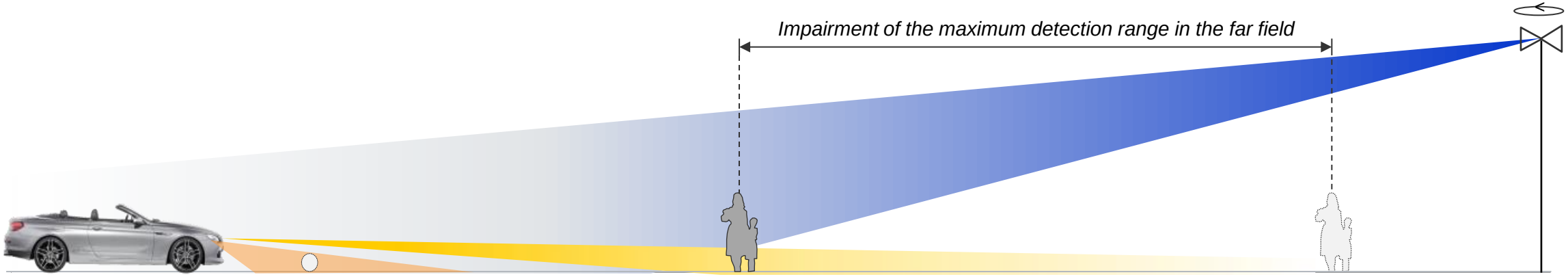
76 – 77 GHz Frequency Band

Propagation of interference along the victim radar signal processing chain



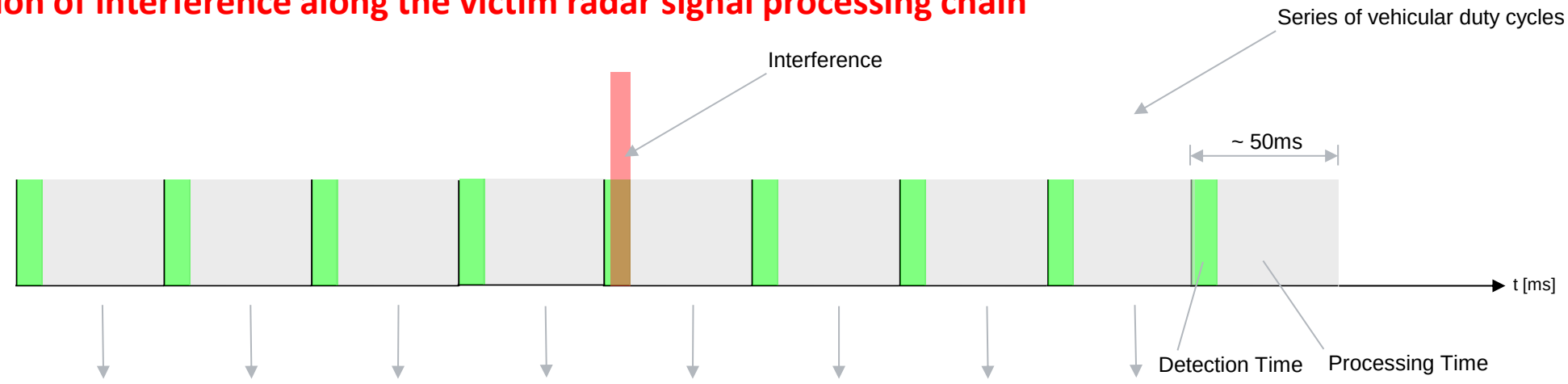
Interference

- A rise in the noise floor translates into a reduction of the maximum vehicular radar‘s detection range.
- The diagram on the left quantifies the reduction of maximum detection range; depending on the Signal to Noise impairment.



76 – 77 GHz Frequency Band

Propagation of interference along the victim radar signal processing chain



Object Detection and Target Identification

Raw Target List	Raw Target List	Raw Target List	Raw Target List	**reduced Target List**	Raw Target List	Raw Target List	Raw Target List

Track Formation:
A certain number of n target lists will be used to generate objects from the targets and to assign track information to these objects.

Hampered Track Formation:
If targets are lost due to interference, track formation will be delayed.

Object not yet added to list	Object not yet added to list	Object not yet added to list	Object not yet added to list	**Object no longer in target list**	**modified Object List**	**modified Object List**	**modified Object List**	Object List

Track-initiation cancelled:
If a given target does not appear on any of these n target lists due to interference, then no object will be created and track formation will be delayed for a full set of another n consecutive target observations.

Delayed System output to the driver or the vehicle

76 – 77 GHz Frequency Band

Summary

ITU recommends the allocation of the 77.5 – 78 GHz band to the radio location service

- To create a continuous frequency band from 76 – 81 GHz to support automotive high-resolution short-range radars; and
- To create a globally harmonized and efficient use of spectrum.

Vehicular Radar Systems

- Help to increase the comfort and safety of contemporary vehicles.
- Are a key technology to enable autonomous driving.
- Are a homogeneous group of applications.
- Are well known and have been extensively described.
- Have been thoroughly studied.
- Have three consolidated design forms (SRR, MRR, LRR)
- Follow common tasks and signal design principles.
- Are self restricting and designed to use spectrum efficiently.
- Have found solutions to mitigate ***known signals***.
- Mitigation technologies are being implemented with every new sensor generation according to real life experience.
- Legacy systems cannot be updated.

Fixed Radar Applications

- Have very heterogeneous tasks.
- May have a wide range of signal characteristics.
- Have not been precisely described and therefore are hard to classify.
- Have not been thoroughly studied.
- Have not proven that they are designed to use spectrum efficiently.
- Have not proven their compatibility with the existing primary and secondary services in the 76 – 81 GHz band.
- Have not even proven that sharing amongst fixed radars is possible.
- Cause interference to vehicular radars due to the nature of their signals.
- This interference can impair automotive radar-based driver assistance systems.
- The existing regulation allows much more damaging fixed radar applications.

Regarding 77 to 81 GHz Band

- Should be exclusively reserved for automotive high resolution radars.
- This is fundamental for autonomous driving.
- 4 GHz of contiguous bandwidth is in itself a requirement for interference mitigation.
- Autonomous driving will depend on the faultless operation of future radars.

➢ **Any impairment must be limited to the greatest extend possible.**

Regarding the 76 – 77 GHz Band

- We are willing to share the band, as long as it is without impairment to our systems.

76 – 81 GHz Radar Applications

Comments on the FCC's Notice of Proposed Rulemaking

Expanding the available spectrum for Vehicular Radars in the 76 – 81 GHz band

- We enthusiastically support the Commission's proposal to expand vehicular radar use in the 76 – 81 GHz band.
- The FCC's proposal is consistent with current efforts to create a globally harmonized spectrum allocation for vehicular radars in the 76 – 81 GHz band, including the decision at WRC-2015 on Agenda Item 1.18, which closed the gap for a globally harmonized primary allocation for radiolocation in the 76 – 81 GHz band.

Licensing vehicular radars by rule under part 95

- We support authorizing vehicular radar services under Part 95 of the FCC's rules, which will avoid overly burdensome individual licensing requirements but provide vehicular radar with priority status and protection from harmful interference from other users.

The FCC should not allow any new fixed radar applications in the 76 – 81 GHz band

- The automotive industry has repeatedly warned that fixed infrastructure radars create serious safety concerns due to harmful interference.
- The Commission should not allow any new fixed radar applications in the 77 – 81 GHz band at all.
- The FCC should not issue any decision allowing new fixed radar applications in the 76 – 77 GHz band until the characteristics of all such new applications have been clearly described and studied, and the Commission has confirmed that they will not cause interference to incumbent vehicular radar applications.

If, despite our request, the FCC decides in its upcoming decision to allow new fixed radar applications in the 76-77 GHz band, it should harmonize its decision with the European regulations. Accordingly, fixed radar applications should be:

- Allowed only in the 76 – 77 GHz band and only if shown to be compatible with vehicular radar; and
- Restricted to a bandwidth of no more than 1 gigahertz.

To protect vehicular radar systems from interference, fixed infrastructure radar systems should be subordinate to vehicular radar systems in the 76-77 GHz band and:

- Allowed only on an unlicensed basis under Part 15; or
- Be subject to site-based licensing to avoid installations in critical environments like tunnels.